

ANATOMY & PHYSIOLOGY

DOE #5276

CIP Code: 26.0403 Anatomy

Anatomy & Physiology is a course in which students investigate concepts related to the health sciences. Through instruction, including laboratory activities, students apply concepts associated with human anatomy and physiology. Studies will include the process of homeostasis and the essentials of human function at the level of genes, cells, tissues, and organ systems. Students are to understand the structure, organization, and function of the various components of the healthy human body in order to apply this knowledge in all health-related fields.

Students enrolled in this course should have a basic understanding of the indicators in the following subsections of Standard 1, Principles of Biology (Biology 1, ISBE 2000):

- Molecules and Cells
- Developmental and Organismal Biology
- Genetics

Students should also know the principles of atomic structure, bonding, molecules, and structural formulas, types of chemical reactions, principles of acids and bases, and molarity.

The course should include ample laboratory experiences that illustrate the application of the standards to the appropriate cells, tissues, organs, and organ systems. Dissection is both appropriate and necessary. Students should be able to use basic laboratory equipment such as microscopes, balances, and pipettes.

- Recommended Grade Level: 11-12
- Required Prerequisite: First-Year course of same discipline (Biology)
- Recommended Prerequisite: Chemistry, Introduction to Health Care Systems
- Credits: A two-semester course, one credit per semester
- A Core 40, Core 40 with Academic Honors, and Core 40 with Technical Honors diploma directed elective course
- A Career Academic Sequence, Career-Technical program, or Flex Credit course; also counts as Core 40 “2 additional credits” science
- Academic content standards: http://www.doe.state.in.us/octe/health/hce/anatomy_physiology.pdf
- Curriculum Framework: http://www.doe.state.in.us/octe/health/hce/anatomy_physiology.pdf
- Teacher Requirements: <http://doe.state.in.us/dps/licensing/assignmentcode>
- Funding: State Additional Pupil Count (APC) vocational funding available if taught by CTE licensed Health Sciences teacher

Standard 1

Cells and Tissues with Related Membranes

Students should understand that molecules make up the fabric of living cells, which, in turn, make up tissues. Students should know the role of adhesion molecules, the classification of tissues, and the various cell types found in them.

- AP 1.1 Compare and contrast the different ways in which substances cross the plasma membrane including diffusion and osmosis, facilitated diffusion, active transport, endocytosis, and exocytosis.
- AP 1.2 Describe the importance of proteins in cell function and structure. Give specific examples of proteins and their functions and describe how proteins are synthesized.
- AP 1.3 Describe the general structure of an epithelium including the basement membrane. Describe the types and locations of epithelia. Describe endocrine and exocrine glands and their development from glandular epithelium. Compare and contrast epithelial and synovial membranes.
- AP 1.4 Compare and contrast the structure, function, and location of cells that make up the various types of muscle tissue, nerve tissue, and connective tissue.

- AP 1.5 Discuss the important physiological functions of the skin. Describe the structure of the skin, including the hypodermis, dermis, and the layers of the epidermis. Discuss the accessory structures of the skin: hairs, nails, and glands.

Standard 2

Movement and Support in Humans

Students know the physiology and structure of bones and skeletal muscle as they interact to provide movement and support of the human body. Students understand the chemical and microscopic structure of bone; its development, repair, turnover and growth; and its ability to heal when damaged. Students know that although the skeleton is made up of rigid bones, many joints allow for movement.

BONE STRUCTURE AND PHYSIOLOGY, THE SKELETON AND THE JOINTS

- AP 2.1 Explain the anatomical position and the terms that describe relative positions, body planes, and body regions. Describe the body cavities, their membranes, and the organs within each cavity; the major organ systems; and their role in the functioning of the body.
- AP 2.2 Distinguish bones according to shape and describe the major functions of bone. Describe the structure of a typical long bone and indicate how each part functions in the physiology and growth of the bone.
- AP 2.3 Compare and contrast the microscopic organization of compact (cortical) bone and spongy (trabecular) bone. Describe the types of cell found in bone and their role in bone growth and control of bone mass.
- AP 2.4 Distinguish the axial from the appendicular skeleton, and name the major bones of each. Locate and identify the bones and the major features of the bones that make up the skull, vertebral column, thoracic cage, pectoral girdle, upper limb, pelvic girdle, and lower limb.
- AP 2.5 Describe the major types of joints in terms of their mobility and the tissues that hold them together. Describe the structures that make up a synovial joint; describe synovial fluid and its properties.

MUSCLE STRUCTURE AND PHYSIOLOGY

- AP 2.6 Compare and contrast the microscopic structure, organization, function, and molecular basis of contraction in skeletal, smooth, and cardiac muscle.
- AP 2.7 Name the components of a skeletal muscle fiber and describe their functions. Describe how the thin and thick filaments are organized in the sarcomere. Explain the molecular processes and biochemical mechanisms that provide energy for muscle contraction and relaxation.
- AP 2.8 Describe a motor unit and its importance in controlling the force and velocity of muscle contraction. Describe the neuromuscular junction and the neurotransmitter released at the neuromuscular junction.
- AP 2.9 Identify the major muscles on a diagram of the body's musculature and describe the movements associated with each of them.
- AP 2.10 Distinguish between isotonic and isometric contractions of skeletal muscle; cite examples of each and discuss how muscle contraction is amplified by the use of lever systems.
- AP 2.11 Explain what is meant by muscular hypertrophy and atrophy and the causes of these conditions.

Standard 3

Nervous Tissue and Neurophysiology

Students recognize that the nervous system, together with the endocrine system, controls and integrates the workings of the human body. Students recognize that nerve cells are the functional cellular units of the nervous system and that their activity calls for rapid transmission of information along their axons as well as an ability to network by "talking" to other nerve cells.

- AP 3.1 Discuss the three basic types of activity in the nervous system: (1.) sensory; (2.) integration, interpretation, information storage, decision-making; (3.) motor function. Distinguish the structures of the various functional types of neurons; diagram the structure of a motor neuron and explain the function of each component.
- AP 3.2 Describe the different types of neuroglial cells. Describe the function of oligodendrocytes and Schwann cells; describe the structure and function of the myelin sheath and the role that Schwann cells play in regeneration of a severed nerve axon.
- AP 3.3 Discuss mathematically the origin of the resting potential, referring to the intra- and extracellular concentrations of sodium and potassium ions, the permeability of the plasma membrane to these ions, and the intracellular concentration of negatively-charged proteins.
- AP 3.4 Explain the changes in membrane potential during the action potential and their relationship to the number of open channels for sodium and potassium ions.
- AP 3.5 Explain the role of excitatory and inhibitory neurotransmitters in a synapse. Explain why it is important to remove a neurotransmitter after it has been released and describe two mechanisms for doing this.

Standard 4

Structure and Function of the Nervous System

Students should understand that the nervous system is divided into the peripheral nervous system and the central nervous system. Students should be familiar with the structure and functions of the subdivisions of the brain. They should also know that diseases of this part of the brain cause marked impairment of motor function. Students should know the cerebellum may play an important role in the learning of motor skills.

- AP 4.1 Recognize that the nervous system is divided into the peripheral nervous system and the central nervous system.
- AP 4.2 Describe the cavities in which the brain and spinal cord are found. Describe the meninges that cover the brain and spinal cord. Describe the ventricles in the brain and how they are interconnected.
- AP 4.3 Describe the secretion, flow pathways, and absorption of cerebrospinal fluid, its locations, and explain its functions.
- AP 4.4 Discuss the functions of the spinal cord. Describe the five segments (regions) of the spinal cord and explain its organization in terms of gray matter; white matter; dorsal and ventral roots.
- AP 4.5 Describe a dermatome and its clinical importance.
- AP 4.6 Describe the various types of spinal reflex and discuss their importance with regards to posture and avoidance of painful stimuli.
- AP 4.7 Discuss the components and broad function of the brain stem and the diencephalon. Describe and give the functions of the various structures that make up the cerebrum including the cerebral cortex and its anatomical divisions, the cerebral components of the basal ganglia, and the corpus callosum.
- AP 4.8 Describe the functions and locations of the motor, sensory, and association areas of the cerebral cortex.
- AP 4.9 Explain hemispheric dominance.
- AP 4.10 Describe the structure and functions of the cerebellum and its nuclei regarding postural control, smooth coordination of movements, and motor learning.

- AP 4.11 Describe the major characteristics of the autonomic nervous system and contrast its efferent pathways with those of somatic nervous system. Compare and contrast the actions, origins and pathways of nerve fibers in the parasympathetic and sympathetic divisions of the autonomic nervous system including their associated ganglia and neurotransmitters.
- AP 4.12 Explain how the cells of the adrenal medulla supplement the actions of the autonomic nervous system

Standard 5

Sensory Systems

Students should describe the structure and function of sensory receptors and their role in human survival.

SOMATIC SENSES

- AP 5.1 Distinguish between somatic senses and special senses and classify sensory receptors according to the types of stimuli that activate them.
- AP 5.2 Explain how information on stimulus intensity and stimulus quality is signaled to the brain.
- AP 5.3 Explain what is meant by sensory receptor adaptation and give examples related to everyday experience.

SPECIAL SENSES

- AP 5.4 Describe the structure, function, and location of olfactory and taste receptor cells.
- AP 5.5 Name the parts of the eye: compare the function of the parts involved in light detection with the parts defining the optical properties of the eye. Describe the cells found in the neural retina and the functional dependence of the rods and cones on the pigmented epithelium (the non-neural retina). Compare the structure of rods and cones, describe the fovea and its function, and discuss the relationship of rods and cones to visual acuity, night vision, dark-adaptation, color vision, and color blindness.
- AP 5.6 Describe the three regions of the ear. Distinguish the structure and function of the vestibular apparatus from the auditory apparatus. Describe how sound is transmitted from the external auditory meatus to the cochlea.
- AP 5.7 Explain how the hair cells in the vestibular apparatus and cochlea respond to head tilt, linear acceleration, rotation, and sound.

Standard 6

Endocrine System

Students understand the structure and function of the endocrine system in relation to digestion and metabolism, homeostasis, survival, growth, development, and reproduction

- AP 6.1 Discuss the difference between an endocrine gland and an exocrine gland. Explain the nature of a hormone and the importance of the endocrine system in relation to digestion and metabolism, homeostasis, survival, growth, development, and reproduction. Contrast the endocrine glands that are purely endocrine with endocrine tissue found in organs that also have other functions.
- AP 6.2 Identify the various chemical classes to which hormones belong and explain that some hormones act via second messengers while others affect gene expression.
- AP 6.3 Discuss neural, hormonal, and other chemical compounds that control hormone secretion. Using examples, describe negative feedback in the control of hormone secretion.
- AP 6.4 Describe the structure and hormones of the hypothalamus-pituitary complex, and the function of these hormones in controlling the thyroid, gonads, and adrenal cortex. Describe structure of these glands and the functions of the hormones secreted by them. For the glands that are not under the control of the

hypothalamus (-pituitary complex - the parathyroid, the pancreas, the pineal gland, and the adrenal medulla), describe their structure, the hormones secreted and their function, and their stimuli for secretion.

- AP 6.5 Discuss how the hypothalamus-pituitary complex, the sympathetic nervous system, the adrenal medulla, and the adrenal cortex are all involved in the response of the body to stress.

Standard 7

The Blood

Students understand the functions of blood including its role in essential protection to combat invading microorganisms, acute inflammation, and immune responses.

- AP 7.1 Describe the functions of the blood and distinguish whole blood from plasma and serum. Classify and explain the functions of the formed elements found in blood, and describe where they are produced.
- AP 7.2 Describe how erythropoietin regulates red blood cell production in response to anoxia.
- AP 7.3 Explain the ABO blood types and discuss their importance during a blood transfusion.
- AP 7.4 Describe hemostasis and the basic processes in blood clotting.

Standard 8

The Cardiovascular System

Students recognize the anatomy and function of the heart and blood vessels. They should also understand that diseases of the cardiovascular system are a major cause of death in this country and, therefore, it is important to understand the normal physiology of the heart and blood vessels.

THE HEART AND BLOOD VESSELS

- AP 8.1 Discuss the functions of the circulatory system; describe with the aid of a diagram the basic arrangement of the cardiovascular system and the blood flow through it (include the pulmonary and systemic circuits.) Describe how oxygen and carbon dioxide are transported in the blood.
- AP 8.2 Describe the layers found in the walls of blood vessels and discuss the relative prominence of these layers in the different types of blood vessels. Include an analysis of vasoconstriction and vasodilatation and their importance in controlling blood flow through tissues. Describe both the venous pump and varicose veins.
- AP 8.3 Diagram the structure of a capillary bed and explain how materials move in and out of capillaries. Discuss edema.
- AP 8.4 Describe the heart: include the pericardium, the layers in its wall, the four chambers, the valves, and the great vessels entering and leaving the heart. Describe the major arteries branching off from the aorta, and the regions they supply; describe the major veins draining into the superior and inferior vena cavae. Explain with diagrams how the heart valves ensure one-way blood flow during systole and diastole. Discuss the heart sounds and the point in the cardiac cycle when they are heard.
- AP 8.5 Discuss the importance of the baroreceptor reflex in the regulation of blood pressure. Explain what is meant by hypertension and mention some of the dangers associated with hypertension.

ELECTRICAL ACTIVITY OF THE HEART AND THE ELECTROCARDIOGRAM

- AP 8.6 Describe how the action potential of a cardiac muscle cell differs from that of a neuron. Describe the importance of calcium ion influx during the plateau phase of the action potential. Discuss the functioning of pacemaker cells and the how the wave of depolarization is transmitted to the ventricles
- AP 8.7 Explain origins of the waves of the electrocardiogram and their medical significance in diagnosis of a heart problem.

ADJUSTMENT OF THE CARDIOVASCULAR SYSTEM TO EXERCISE AND HEMORRHAGE

- AP 8.8 Explain the similarities and differences between the adjustment of the cardiovascular system to exercise and hemorrhage. Contrast changes in the distribution of blood flow and cardiac output, and explain the importance of the sympathetic branch of the autonomic nervous system in these responses.

Standard 9

The Lymphatic System

Students should understand the role of the lymphatic system in the body's defense against marauding pathogens. Students should also understand that many of the cells of the immune system are formed, reside in, are processed in, or travel within and through the structures of the lymphatic system. Students should understand these structures, classify them, and know their location.

- AP 9.1 Discuss the major anatomical structures and functions of the lymphatic system including the lymphatic vessels; the structure and major groupings of lymph nodes; and the structures and functions of the spleen, thymus, and bone marrow.

Standard 10

Immune Mechanisms

Students should know that pathogens attempt to invade our bodies to take advantage of our nutrients and our protein synthetic machinery. Students should understand the various lines of defense including the two immune systems that save us from certain death by infection. Students should know the cellular and non-cellular components of the innate, natural, non-specific immune system and the specific, acquired immune system.

- AP 10.1 Discuss the different types of pathogens and outline the strategies the body uses to protect itself from them. Distinguish non-specific, innate or natural immunity from specific or acquired immunity. Recognize their overlap and describe their cellular and non-cellular components.
- AP 10.2 Describe the mechanisms of the acute inflammatory response, its causes, and the role of chemical signaling molecules.
- AP 10.3 Describe the development and maturation of B- and T-lymphocytes. Discuss why the development of self-tolerance is important.
- AP 10.4 Define and discuss antigens, antibodies, and complement.

Standard 11

The Respiratory System

Students should understand why it is necessary to breathe. They should understand how breathing is controlled, how the mechanical aspects of the breathing processes occur, and how ventilation of the lungs changes in response to changes in blood oxygen, carbon dioxide, and pH.

- AP 11.1 Recognize that breathing supplies oxygen that is critical for oxidative phosphorylation. Describe the anatomy of the respiratory system and the route taken by the inspiratory flow of air from the nose into the alveoli.
- AP 11.2 Contrast inspiration and expiration (quiet and forced) and explain the role of various muscles and of lung elasticity in this process. Compare the percentages of the oxygen and carbon dioxide in the external air to the percentages in the alveolar and the pulmonary capillaries. Explain the meaning of partial pressure.
- AP 11.3 Explain the use of the spirometer and describe the data it generates in a spirogram.
- AP 11.4 Describe the neuronal networks controlling respiration. Contrast and compare the chemoreceptors involved in control of respiration and the stimuli to which they respond. Explain how these receptors affect ventilation under conditions of low arterial oxygen partial pressure, high arterial carbon dioxide, and low arterial pH.

Standard 12

The Digestive System

Students should be able to define the digestive system and to state the structures, regulators, and functions of its primary and accessory structures and organs. Students should be able to explain why food is essential for life. They should understand the anatomy of the splanchnic circulation and its relationship to the liver.

- AP 12.1 Describe the organs and organ relationships of the gastrointestinal tract and the cells and layers found in its walls. Include the salivary glands, liver and pancreas.
- AP 12.2 Describe the functions of all the structural components and enzymes of the gastrointestinal tract and accessory organs in relation to the processing, digesting, and absorbing of the three major food classes. State the chemical forms in which the three major food classes are absorbed. Explain the roles of the lacteals and the hepatic portal vein in transporting the products of digestion.
- AP 12.3 Describe the regulation of the enzyme and bicarbonate content of the pancreatic juice.
- AP 12.4 Describe the microscopic anatomy of the liver and its relationship to the functions of the liver.

Standard 13

The Urinary System

Students should understand the microscopic and macroscopic anatomy of the renal system. Students should understand the function of the kidneys in relation to homeostatic control of bodily fluids, blood pressure, and erythrocyte production. They should understand micturition, the properties of urine and the physiological processes involved in the production of urine. Students should understand the importance of a high blood flow through the kidneys and the kidney's role in control of sugar, salts, and water.

- AP 13.1 Discuss the functions of the kidneys. Describe the anatomy of the renal system, including the gross anatomy, blood supply, and location of the kidneys, and the layers in the walls of the ureters and urinary bladder.
- AP 13.2 Explain the neural basis of micturition including the function of the sphincters associated with the male and female urethra.
- AP 13.3 Describe the internal structure of the kidney; describe the parts of a nephron and how they are involved in the three steps in the production of urine; compare the composition of plasma and ultrafiltrate and discuss the percentages of filtered water, sodium, and glucose normally reabsorbed by the kidney tubules.
- AP 13.4 Explain the importance of the juxtaglomerular cells in the secretion of renin, which plays a central role in controlling blood pressure by controlling blood levels of angiotensin and aldosterone.

Standard 14

Fluid, Electrolyte and Acid-Base Balance

Students should explain how we control the salt content and volume of the fluid that surrounds the cells of our bodies and why this control is necessary. Students should be able to explain why it is necessary to control the pH of the fluids in our bodies. They should be able to define alkalosis and acidosis. Students should know the various sources of acid and the three ways in which the body defends itself against lethal changes of pH.

- AP 14.1 Contrast the volume and electrolyte content of the intracellular and extracellular fluid compartments. Explain the importance of sodium, potassium, and calcium in the body's physiology.
- AP 14.2 Discuss how the volume of body fluid is determined by the balance between ingested and metabolic water on the one hand and water lost in the urine, respiration, feces, and sweating on the other hand. Describe the factors that generate the sensation of thirst. Describe how the kidneys respond to excess water intake and to dehydration; explain the role of antidiuretic hormone and of other hormones that control sodium and water absorption in the kidney.

- AP 14.3 Describe how food and metabolic processes add acid to the body fluids; recognize how chemical buffers, the lungs and the kidneys, interact in protecting the body against lethal changes of pH.
- AP 14.4 Explain the difference between metabolic and respiratory acidosis and alkalosis.

Standard 15

Structure, Function and Hormonal Control of the Male and Female Reproductive Systems, Fertilization, Early Embryonic Development, Pregnancy, and Parturition

- AP 15.1 Discuss the anatomy and physiology of the male and female reproductive systems. Compare and contrast oogenesis and spermatogenesis. Distinguish between diploid germ cells and haploid/monoploid sex cells.
- AP 15.2 Describe the hormones of the gonads, their cell origins, and their functions; explain the functions of the gonadotropins FSH and LH in males and females.
- AP 15.3 Explain what is happening during the follicular, ovulatory, and luteal phases of the menstrual cycle. Describe how estradiol and progesterone released by the ovaries are responsible for the phases that the uterus goes through during the menstrual cycle.
- AP 15.4 Describe how spermatozoa move through the female reproductive tract and describe the process of fertilization.
- AP 15.5 Explain the differences among dikaryon zygote, a zygote, a morula, and a blastocyst; recognize that the blastocyst secretes human gonadotropin, which prolongs the life of the corpus luteum and therefore, maintains levels of progesterone. Describe the process of implantation, development of the placenta, the substances that move across it, and the role of the placenta in maintaining the high levels of progesterone essential for a successful pregnancy.
- AP 15.6 Describe the changes in the breast for lactation, the hormonal events that initiate milk secretion, the maintenance of milk secretion by the breasts, and the milk ejection reflex.